Claim Amendments

1.(currently amended)_ A method of JPEG compression of an image frame divided up into a plurality of non-overlapping, tiled 8 x 8 pixel blocks ~~B_{ij}~~ X_i comprising:

(a) forming a discrete cosine transform (DCT) of each block ~~B_{ij}~~ X_i of the image frame to produce a matrix of blocks of transform coefficients ~~D_{ij}~~ Y_i;

(b) calculating a visual importance, ~~I_{ij}~~ I_i, for each block of the image, based upon assigning zeros for flat features and values approaching unity for sharply varying features;

(c) forming a global quantization matrix Q by one of

(i) selecting a standard JPEG quantization table and

(ii) selecting a quantization table such that the magnitude of each quantization matrix coefficient ~~Q_{ij}~~ $Q[m,n]$ is inversely proportional to the aggregate visual importance in the image of the corresponding DCT basis vector; and

(d) ~~selecting~~ calculating linear scaling factors ~~S_{ij}~~ S_i defining bounds over which the image is to be variably quantized;

(e) ~~quantizing the transform coefficients, D_{ijmn}, by an equivalent of dividing them by a factor $S_{min}*Q$, where S_{min} is a user selected minimum scaling factor, and~~ approximating variable quantization of the transform coefficients, $Y_i[m,n]$, using the local quantization table S_i Q while actually producing coefficients $T_i[m,n]$ that have been quantized using global quantization table S_{min} Q; and

(f) entropy encoding quantized coefficients ~~T_{ijmn}~~ $T_i[m,n]$ and global quantization table S_{min} Q to create a JPEG Part 1 image file.

2.(currently amended) A method according to claim 1, wherein step (e) includes rounding ~~$D_{ijmn}/(S_{min}*Q))$~~ $Y_i[m,n]/(S_{min}\ Q[m,n])$ to the nearest integer to form quantized DCT transformed coefficients ~~T_{ijmn}~~ $T_i[m,n]$;

(f) setting ~~T_{ijmn}~~ $T_i[m,n]$ = 0 if ~~round$(D_{ijmn}/(Q_{mn}*S_{ij}))$~~ round$(Y_i[m,n]/(S_i\ Q[m,n]))$ = 0; and

(g) setting ~~T_{ijmn}~~ = ~~sign$(D_{ijmn})*(2\hat{}(ceil(lg(abs(D_{ijmn})+1))1)-1)$ if abs(D_{ijmn}) $(2\hat{}(ceil(lg(abs(D_{ijmn})+1)-1)$ is less than or equal to abs$(D_{ijmn}$ $Q_{mn}S_{ij}*$ round$(D_{ijmn}/(S_{ij}*Q_{mn})))$,~~ setting $T_i[m,n]$ = sign$(T_i[m,n])$ $P(T_i[m,n])$ if $Ernd_i[m,n]$ is less than or equal to $Evq_i[m,n]$.

3.(currently amended) A method according to claim 1, including calculating a linear scaling factor S_{ij} $\underline{S_i}$ equal to ~~I_{ij}~~ $\underline{I_i} * (S_{max} - S_{min}) + S_{min}$ where S_{min} and S_{max} are user specified to define bounds over which the image will be variably quantized.

4.(currently amended) The method according to claim 1, where ~~I_{ij}~~ $\underline{I_i}$ is determined by discrete edge detection and summation of transform coefficients.

5.(currently amended) The method according to claim 1, wherein ~~I_{ij}~~ $\underline{I_i}$ is determined by creating a 24 x 24 matrix of image pixels of DCT coefficients centered on a block ~~B_{ij}~~ $\underline{X_i}$, ~~where I and j =1, 2, 8,~~ convolving said 24 x 24 matrix with an edge tracing kernel to produce a convolved matrix, summing center 10 x 10 matrix values of said convolved matrix to produce a summed value, and normalizing said summed value to produce a visual importance, ~~I_{ij}~~ $\underline{I_i}$.

6.(currently amended) The method according to claim 1, wherein said global quantization matrix Q is formed by calculating an 8 x 8 matrix A by calculating matrix elements ~~A_{mn}~~ A[m,n] of said A according to the formula

~~$A_{mn} = I_{ij}(B_{ij})_{mn}$~~

$$\underline{A[m,n] = \sum_{\text{all } i} I_i \, Y_i[m,n]}$$

calculating elements Q_{mn} of said Q according to the formula

~~$Q_{mn} = \max(A_{mn})_{mn}$~~

Q[m,n] = max(entries of A)/A[m,n]

and scaling ~~values of Q_{mn}~~ coefficients of Q by a constant factor s for all values of (m,n) except (0,0) in order to minimize an error between Q and a standard JPEG quantization matrix.

7. (currently amended) A method of JPEG compression of an image frame divided up into a plurality of non-overlapping, tiled 8 x 8 pixel blocks ~~B_{ij} X_i where i, j are integers covering all of the blocks in the image frame~~, comprising:

(a) forming a discrete cosine transform (DCT) of each block ~~B_{ij}~~ X_i of the image frame to produce a matrix of blocks of transform coefficients ~~D_{ij}~~ Y_i;

(b) calculating a visual importance, ~~I_{ij}~~ I_i, for each block of the image, based upon assigning zeros for flat features and values approaching unity for sharply varying features;

(c) forming a global quantization matrix Q by one of

(i) selecting a standard JPEG quantization table and

(ii) selecting a quantization table such that the magnitude of each quantization matrix coefficient

~~Q_{ij}~~ $Q[m,n]$ is inversely proportional to the aggregate visual importance~~, I_{ij},~~ to the image of ~~a~~ the corresponding DCT basis vector; and

(d) selecting a linear scaling factor ~~S_{ij}~~ S_i defining bounds over which the image is to be variably quantized wherein ~~S_{ij}~~ $S_i = I_{ij} - I_i (S_{max} - S_{min}) + S_{min}$, where S_{max} and S_{min} are user selected;

(e) quantizing the transform coefficients, ~~D_{ij}~~ $Y_i[m,n]$, to produce quantized blocks ~~T_{ijmn}~~ $T_i[m,n]$ as follows:

(i) ~~$T_{ijmn} = \text{round}(D_{ijmn}/(S_{min} * Q_{mn}))$~~ $T_i[m,n] = \text{round}(Y_i[m,n]/(S_{min} Q[m,n]))$, where round denotes rounding to the nearest integer;

(ii) setting ~~T_{ijmn}~~ $T_i[m,n] = 0$ if ~~round $(D_{ijmn}/(Q_{mn} * S_{ij}))$~~ $\text{round}(Y_i[m,n]/(S_i Q[m,n])) = 0$; and

(iii) setting ~~$T_{ijmn} = \text{sign}(D_{ijmn}) + 1)) - 1)$~~ $T_i[m,n] = \text{sign}(T_i[m,n])\ P(\text{abs}(T_i[m,n]))$ if ~~$\text{abs}(D_{ijmn})) 2\hat{}(\text{ceil}(\lg(\text{abs}(D_{ijmn}) + 1) - 1) - 1)$~~ $Ernd_i[m,n]$ is less than or equal to ~~$(\text{abs}(D_{ijmn} - Q_{mn} * S_{ij} * \text{round}(D_{ijmn}/(S_{ij} * Q_{mn}))))$~~ $Evq_i[m,n]$;

(f) entropy encoding quantized coefficients ~~T_{ijmn}~~ $T_i[m,n]$ and global quantization matrix S_{min} Q, to create a JPEG Part 1 image file.

8.(currently amended) A method of JPEG compression of a colour image represented by channels Y for greyscale data, and U and V each for colour, comprising:

(a) ~~shrinking~~ subsampling the colour channels U and V by ~~a~~ an integer fraction of their size;

(b~~a~~) forming a discrete cosine transform (DCT) ~~B_{ij}~~ Y_i for each block ~~B_{ij}~~ X_i of each of channels Y, U and V;

(c~~b~~) calculating a visual importance, ~~I_{ij}~~ I_i, for each Y channel block of each image and setting ~~I_{ij}~~ I_i = max{~~I_{ij}~~ I_i values for corresponding Y channel blocks} for blocks in the U and V channels;

(d~~c~~) forming a global quantization matrix Q for the Y channel block and one for channels U and V combined such that a magnitude of each quantization matrix coefficient ~~Q_{ij}~~ Q[m,n] is inversely proportional to ~~an~~ the aggregate visual importance in the image of ~~a~~ the corresponding DCT basis vector; and

(e~~d~~) approximating variable quantization of the transform coefficients, $Y_i[m,n]$, using the local quantization table S_i Q while actually producing coefficients $T_i[m,n]$ that have been quantized using global quantization table S_{min} Q, where Q is the global quantization table for the associated channel being quantized; and ~~quantizing the transform coefficients for~~

~~each of the Y, U and V channels by dividing them by a factor S_{ij} Q', where S_{ij} is a linear scaling factor for each of channels Y, U and V and Q' is the quantization table for the associated channel being quantized; and~~

(~~f~~e) entropy encoding quantized coefficients ~~T_{ijmn}~~ $T_i[m,n]$ and ~~$Q'*S_{min}$~~ global quantization table S_{min} Q, where S_{min} is a user selected minimum scaling factor for each of channels Y, U, and V, to create a JPEG Part 1 image file for each of channels Y, U and V.

9.(currently amended) The method of claim 8 wherein the ~~shrinking~~ subsampling factor is ~~1/2~~ 2.

10.(currently amended) Apparatus for JPEG compression of an image frame divided up into a plurality of non-overlapping, tiled 8 x 8 pixel blocks ~~B_{ij}~~ X_i ~~where I, j are integers covering all of the blocks in the image frame,~~ comprising:

(a) a discrete cosine transformer (DCT) operative to form the ~~deiscrete~~ discrete cosine transform of each block ~~B_{ij}~~ X_i of the image frame to produce ~~a matrix of~~ blocks of transform coefficients ~~D_{ij}~~ Y_i;

(b) a visual importance calculator operative to calculate the visual importance, ~~I_{ij}~~ I_i, for each block of the image, based upon assigning zeros for flat features and values approaching unity for sharply varying features;

(c) a global quantization matrix calculator operative to calculate the global quantization matrix, Q, by one of

(i) selecting a standard JPEG quantization table and

(ii) selecting a quantization table such that the magnitude of each quantization matrix coefficient ~~Q_{ij}~~ $Q[m,n]$ is inversely proportional to the aggregate visual importance in the image of the corresponding DCT basis vector; and

(d) a linear scaling factor calculator operative to determine a linear scaling factor, ~~S_{ij}~~ S_i, defining bounds over which the image is to be variably quantized based on user established values of S_{max} and S_{min};

(e) a variable quantization operative approximating variable quantization of the transform coefficients, $Y_i[m,n]$, using the local quantization table S_i Q while actually producing coefficients $T_i[m,n]$ that have been quantized using global quantization table S_{min} Q, where S_{min} is a user selected minimum scaling factor; and ~~a quantizer operative to divide the transform coefficients, D_{ijmn}, by a value equivalent to dividing them by a factor S_{min}*Q, where S_{min} is a user selected minimum scaling factor; and~~

(f) an entropy encoder operative to encode the quantized coefficients ~~T_{ijmn}~~ $T_i[m,n]$ and ~~$Q*S_{min}$~~ global quantization table S_{min} Q to create a JPEG Part 1 image file.

11. (currently amended) Apparatus according to claim 10, wherein said quantizer rounds ~~$D_{ijmn}/(S_{min}*Q)$~~ $Y_i[m,n]/(S_{min}\ Q[m,n])$ to the nearest integer to form quantized DCT transformed coefficients ~~T_{ijmn}~~ $T_i[m,n]$ and

(f) sets ~~T_{ijmn}~~ $T_i[m,n]$ = 0 if ~~$round(D_{ijmn}/Q_{mn}*S_{ij}))$~~ $round(Y_i[m,n]/(S_i\ Q[m,n]))$ = 0; and

~~(g)~~ sets ~~T_{ijmn} sign (D$_{ijm}$)*(2^ceil(lg(abs(D$_{ijmn}$)+1)) - 1) 1)~~ $T_i[m,n]$ = sign($T_i[m,n]$) P(abs($T_i[m,n]$)) if ~~abs(D$_{ijmn}$) (2^(ceil(lg(abs(D$_{ijmn}$)+1)) 1) 1)~~ $Ernd_i[m,n]$ is less than or equal to ~~abs(D$_{ijmn}$ Q$_{mn}$S$_{ij}$ * round(D$_{ijmn}$/(S$_{ij}$*Q$_{mn}$)))~~ $Evq_i[m,n]$;

12. (currently amended) Apparatus according to claim 10, wherein said linear scaling factor ~~S_{ij}~~ S_i equal to ~~I_{ij}~~ I_i * (S_{max} - S_{min}) + S_{min} where S_{min} and S_{max} are user specified to define bounds over which the image will be variably quantized.